

Sliced bamboo veneer with non-woven cloth: A new utilization method

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Abstract: Slicing bamboo veneer leads to a new area of development and exploitation of bamboo products. Sliced bamboo enhanced by non-woven cloth has shown high value addition and market potential. This paper briefly introduces the processing technology of sliced bamboo veneer and discusses some basic points which should be considered during sliced bamboo veneer manufacture.

Key words: Sliced bamboo veneer, non-woven cloth, bamboo.

INTRODUCTION

China is one of the main bamboo producing countries in the world, possessing more than 400 species and 40 genera of bamboo. The total area of bamboo resource in China is 4,210,000 ha, with an annual production exceeding 8 million tonne (Qisheng *et al.*, 2003). The rational exploitation of bamboo resource is to substitute wood as raw materials for wood industry and to protect ecological environment. In the recent two decades, China and other countries have paid attention to the industrial use of bamboo and in developing newer products such as ply-bamboo, flooring materials, curtains, composite board, chipboard and various bamboo wares in daily use. However, bamboo utilization has greater potential and requires new processing technologies to widen the field of bamboo application. In this context, the possibility of utilization of sliced bamboo veneers is examined.

Slicing bamboo veneers leads to a new field of exploitation and development of bamboo products. Sliced bamboo veneer enhanced by non-woven cloth has shown some characteristics such as higher added value, convenience in use, and large potential markets. Sliced bamboo veneer combined with non-woven cloth could be used as decorative veneer of furniture surface. It can also be used for decorating and

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refurnishing indoor materials because of the unique grain pattern and good abrasion resistance. For example, it could be used as surface material of the wallboard, floor, ceiling board, etc.

Sliced bamboo veneer can be used in handicraft production because of its excellent plasticity. For example, it is often made into various handicraft products by using different moulds, including dinner plates, fruit bowls, screens, etc.

This paper introduces the production procedure of sliced bamboo veneer. The purpose of this study is to promote development of sliced bamboo veneer for industrial application.

PROCESSING TECHNOLOGY

A flow chart of sliced bamboo veneer preparation is shown as follows:

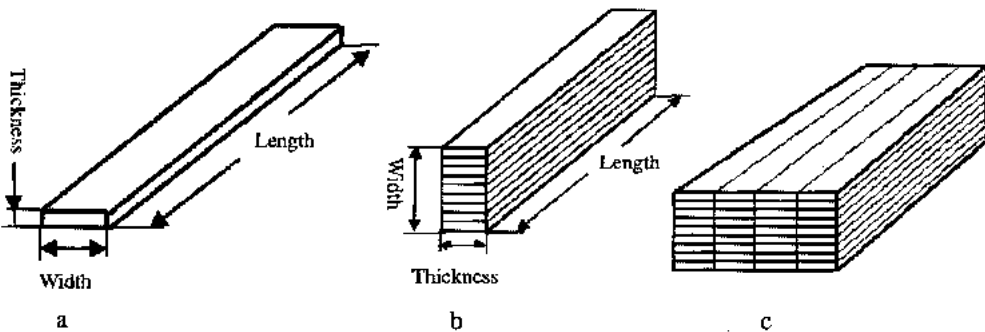
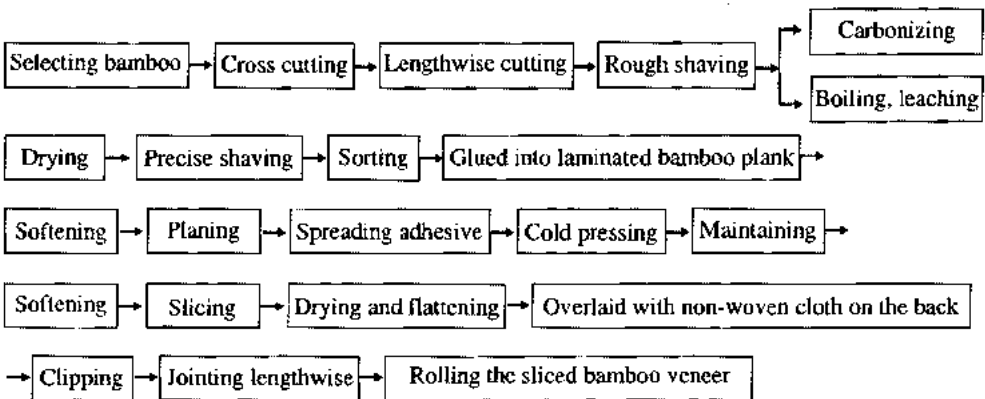


Figure 1. Schematic diagrams of bamboo strip (a); laminated bamboo plank (b); glued laminated bamboo timber (c).

Selecting bamboo

Fresh bamboo of four or more years of age was selected. The diameter of raw bamboo for sliced veneer production should exceed 10 cm, the column should be straight, and the wall should be thick. It is important to select the bamboo properly to improve efficiency in utilization as well as to reduce production cost.

Cross cutting

The selected fresh bamboo was cut into sections of pre-determined length, ranging between 1 and 2 m.

Lengthwise cutting

A coaxial double disc-saw was used to cut bamboo. The strips of similar width were obtained from each bamboo. The width of the strips was determined based on culm diameter normally ranging between 19 and 25 mm. In lengthwise cutting, the small end of column was sawn first to avoid the width shortage of the last strip.

Rough shaving (shaving four sides evenly)

A strip is a part of the circular wall of bamboo section. For further processing, the inner and outer skins were removed and the cross section of the strip was shaped into rectangle.

First of all, the bamboos were sorted into two or three groups with different thicknesses. All the strips were cut into desired thickness and width using a rough shaving machine. During rough shaving, enough margins were guaranteed for further processing.

Boiling and bleaching

Boiling-bleaching is an essential part of the technology for removing starch. Most of the soluble organic materials will be extracted from bamboo, and insects and fungi killed during boiling with bleaching chemical, insecticide and preservatives. Various colours were added to the strips after the treatment.

The practical operation procedure is outlined as follows: Put roughly shaved strips into warm water at 60 °C and add hydrogen peroxide (30%), insecticide and preservative (5-8%); then boil the water with steam for 6 to 8 h. Retrieve the strips after boiling and the water in boiling pool can be reused for the next batch.

Carbonization

Carbonization of bamboo involves high temperature, humidity and pressure. This operation can decompose the organic matter and thus cut off nourishment for insects

and fungi. The colour of carbonized bamboo turns brown, thus giving bamboo veneer an attractive look.

Carbonization is performed as follows: The bamboo strips are placed in a metal basket, moved along a rail into the furnace and draft closed. Then the steam valve is opened to raise the pressure to about 0.3 MPa and maintained the pressure for 70-90 min. Finally, the steam is released, the draft opened and the bamboo strips removed.

Drying

Moisture content of the strips after boiling-bleaching or carbonization is about 35-50 per cent. Because of the small size of the strips, splitting and warping was minimum as compared to wood. Drying of the bamboo strips is done by keeping the temperature within the range of 60-70 °C for 72-84 h to reduce the moisture content to less than 10 per cent. The temperature should not exceed 70 °C, because it will cause excessive warping of the strips.

Precise shaving

In order to make the width and thickness of the strips to meet the processing requirements, precise shaving is performed on a precise shaving machine. The tolerance was kept under 0.1 mm.

Selecting strips

It is very important to examine bamboo strips before gluing and laminating into a rectangular timber, not only to increase the quality rate of final product, but also to reduce the waste. The strips were sorted to maintain colour similarity on glued and laminated bamboo plank. The stained rotting strips, and strips having insect holes and serious warping were discarded. To guarantee the product quality, bamboo strips should be flat and smooth, and should not have processing defects such as ripple, vane, etc. which will not allow intimate contacts between bamboo strips while gluing. Width and thickness tolerance was controlled within ± 0.1 mm. Moisture content of strips was within 10 ± 2 per cent. Only the strips that meet above-mentioned criteria were selected for further processing.

Glued into laminated bamboo plank (side gluing)

Adhesive and gluing operations are other main factors affecting sliced bamboo veneer quality. Bamboo strips were glued with urea formaldehyde (UF) modified by melamine into plank along the thickness direction of bamboo strips. Temperature of hot pressing was 95-110 °C, pressing time 10-14 min, side pressure 2.0 ~ 3.0 MPa, and face pressure 1.0 ~ 1.5 MPa (Yan-jun *et al.*, 2003). The suitable width of laminated bamboo plank generally ranges between 30 and 40 cm. Too wide planks will cause hump and inner stress concentration during producing laminated bamboo plank.

Softening of laminated bamboo plank

The time for softening laminated bamboo plank was determined based on the extent of softening at its centre. Bamboo is water-resistant in nature. The common softening treatment of soaking in hot water at 60 °C with NaHCO₃ for 1-2 days will not get the laminated bamboo plank completely soaked. To improve the effect of softening, treatment under high pressure in a close container was adopted, aiming at accelerating the rate of softening. The technique is as follows: Laminated bamboo plank is softened in water at 60 °C and at 0.4-0.5 MPa pressure for 5-10 h depending on the length of plank. After treatment, the planks should not be kept in water below 30 °C, since the internal stress could be high enough to make the laminated bamboo plank delaminated.

Gluing laminated bamboo plank into laminated bamboo timber

Glued laminated bamboo planks after softening treatment in the pressure vessel were put in the open for a while to let water in the plank exude, to enhance the gluing operation. When gluing laminated bamboo planks into laminated bamboo timber with wet curing isocyanate, the suitable moisture content of laminated bamboo plank should be 50 per cent. If the moisture content is too high, the curing rate could be too fast for proper gluing operation.

When gluing with aqueous polymer isocyanate (API) adhesive, laminated bamboo planks should be air-dried to lower surface moisture content to 20 per cent. After that, planks were planed, glued, pressed at the pressure of 2-3 MPa and maintained for 24 h (Rui-xiang *et al.*, 2003). The bonding surfaces were knife-planed 24 h before bonding.

Slicing

Laminated bamboo timber was soaked in water to further soften for slicing. After softening, it was sliced, while warm temperature above 40 °C was ideal for slicing.

During slicing, the thickness tolerance was maintained at ± 0.03 mm when thickness of sliced bamboo veneer was below 0.5 mm and ± 0.05 mm when thickness of sliced bamboo veneer exceeded 0.5 mm. Angle of knife blade was set at 17-20°. Slicing knife blade should be kept sharp, and the edge of knife should be straight. When markings of knife burrs appear on the surface of sliced veneer, the knife blade should be sharpened.

Drying and flattening

Moisture content of freshly sliced bamboo veneers is quite high. If they are glued directly on non-woven cloth, excessive shrinkage during hot pressing would make them split. In addition, freshly sliced bamboo veneer is easily curled up, it is necessary for sliced bamboo veneer to be flattened. Drying and flattening the sliced bamboo veneers will prevent them from warping and fungal growth. Therefore, sliced bamboo

veneer was dried to a moisture content of 30% under pressure, and then glued on to the non-woven cloth in wet state afterwards.

Overlaying with non-woven cloth

Sliced bamboo veneer is often overlaid with non-woven cloth on its back to increase strength of sliced veneer and prevent it from breaking, and to make the surface flat and smooth. Special adhesive or the adhesive mixture of UF resin and polyvinyl acetate (PVA) emulsion adhesives are used.

When adhesive mixture of UF resin and PVA (weight ratio 1:1) was used, the spread rate was 60 -80 g/m² (one side spread). After 30 min open assembly time, pressure of 0.2-0.5 MPa was applied at a temperature of 95-110 °C for 20-30 min. During hot pressing, the platens should be opened more than twice to remove vapor quickly from the wet sliced bamboo veneer and let it stretch freely.

Jointing lengthwise

Sliced bamboo veneer was finger-jointed. End pressure was 4-6 bars and pressing time was 3 seconds. To increase the efficiency of jointing and the quality of final product, it is important to check the veneer in terms of colour before jointing. Care was taken to keep bamboo strip colour uniform on the same roll or sheet. Meanwhile, thickness tolerance was controlled under ± 0.05 mm, so the variation in height of jointing places will not influence product appearance.

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